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STATE DOCUMENTS

ENGINEERING REPORT
FOR
COMPARISON OF COSTS
OF
ALTERNATE LINES
ON
INTERSTATE ROUTE 90

COLUMBUS EAST

PREPARED BY
MONTANA STATE HIGHWAY COMMISSION
INTERSTATE DIVISION

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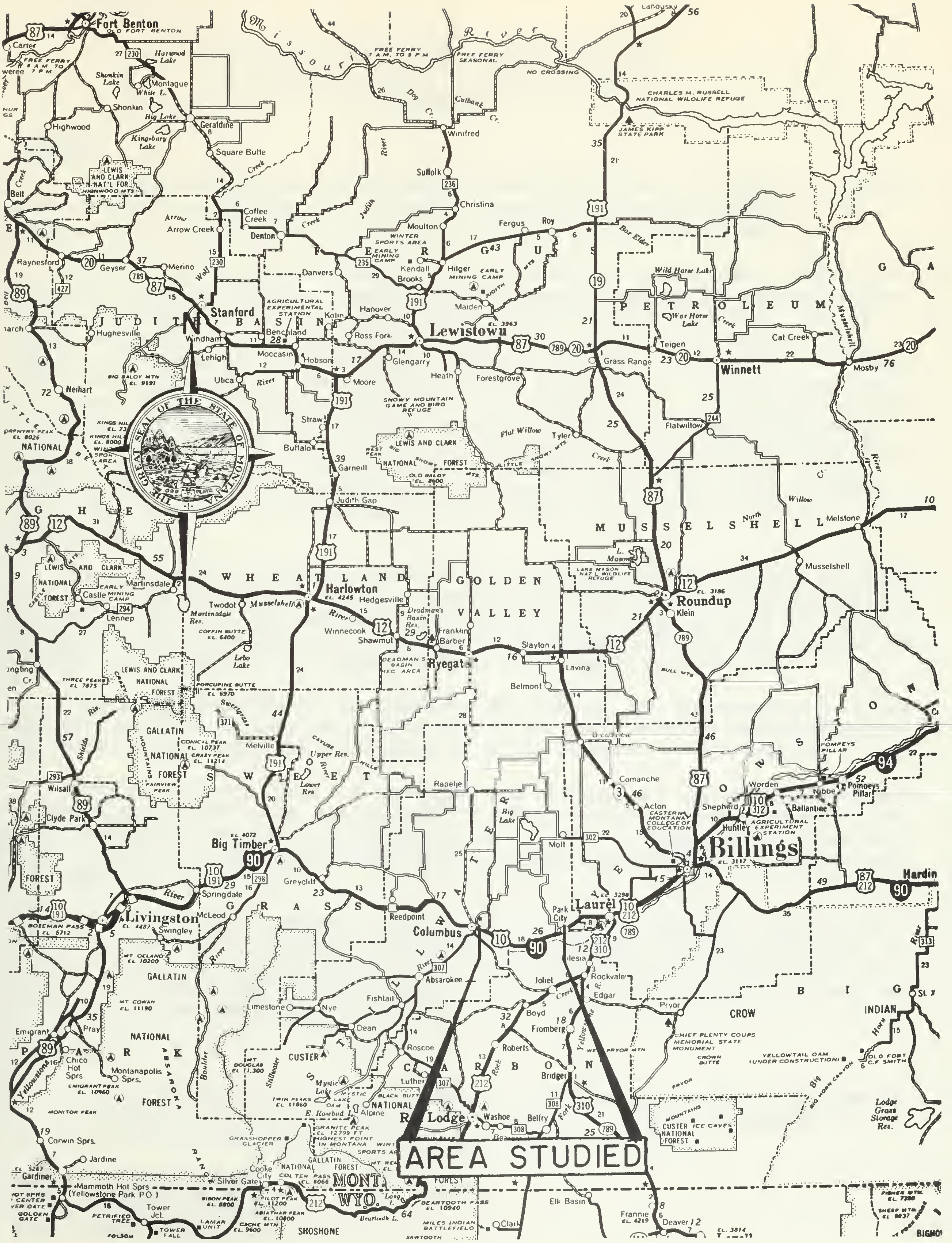

SITUATION MAP

ENGINEERING REPORT FOR COMPARISON OF COSTS OF ALTERNATE LINES ON INTERSTATE ROUTE 90 COLUMBUS EAST

FOREWORD

The Interstate System was originally established under the Federal Aid Highway Act of 1944. It was defined as the National System of Interstate Highways. This original system was included as part of the Federal Aid Primary System.

However, the nation-wide interest in the Interstate System made it evident that it required special attention, both in financing and in expediting the construction to adequate standards to serve the anticipated great increase in traffic volumes. Action to accomplish this objective was contained in legislation as part of the Federal Aid Highway Act of 1956. Under this Act, the name of the system was changed to the National System of Interstate and Defense Highways. It was stipulated that the Interstate System should be completed as practicable over a thirteen-year period. The national interest in the system was recognized by means of greatly increased authorization of Federal Aid to assist in construction of the system and also liberalization of the proportion of Federal money as compared to State money. Much higher standards were prescribed for the construction of this system and included the control of access to the highways so that traffic could move safely and expeditiously.

This report was prepared to compare the relative merits of alternate locations in the vicinity of Columbus, Montana. The principal purpose here is to illustrate in monetary terms the most pertinent considerations involved, including the cost of constructing alternate locations, the cost of maintaining each location, and the cost which will be incurred by the highway user in traveling on each location.

Since the cheapest route to construct and maintain does not always provide the best service to the highway user, it is also necessary to consider vehicular operating costs in determining the route which is of the greatest overall benefit.

Federal and State funds for the support of highways are obtained almost entirely from highway-user taxes; consequently, the most favorable highway location from the standpoint of the people who are paying for it would be the route that has the lowest overall cost when all construction, maintenance and vehicular operating costs are taken into consideration.

The development of Montana's 1200 miles of Interstate Highways requires that a section be built in the vicinity of Columbus in south central Montana. It is to be a link in Interstate Highway 90 which will ultimately extend from Lookout Pass on the Montana-Idaho stateline, through Missoula, Butte, Bozeman, Big Timber, Billings, and Hardin, to the Montana-Wyoming stateline.

STUDY AREA

The study area is in Stillwater County in south central Montana. As shown on the accompanying map, the west terminus of the study is located immediately north of Columbus and the east terminus immeidately west of Park City.

Shortly after the Lewis and Clark Expedition passed through this area on their return trip, fur trading posts were established along the river. Early trails followed the river as sporadic attemps were made in the 1870's to settle in this area. The Northern Pacific Railway was constructed in 1882, following the water-level grade through the valley. With the availability of transportation, Columbus and Park City were established along with the settlement and development of the general area. The early activity was confined almost entirely to raising livestock. With the development of irrigation projects in the valley, hay, sugar beet, and grain crops have supplemented the livestock industry and now the valley is an area of intensive agricultural development. The present highway traverses this area, for the most part paralleling the railroad. With the advent of the modern motor vehicles, the mode of transportation changed. Whereas this area had initially been served principally by the railroad, now the highway is the principal means of moving supplies to and produce from the farm. Thus, the present highway has come to be an important farm-to-market route in this area, as well as a transcontinental highway.

DESCRIPTION OF ROUTES

As shown on the map of the study area, both the North and the South Routes begin immediately north of Columbus.

NORTH ROUTE

The North Route extends easterly to the top of the bluff east of Columbus where an interchange with the local road is proposed. From this point the road extends easterly, following several drainages through the hills for approximately 12 miles. The route returns to the valley and connects to the present highway with an interchange approximately 4 miles west of Park City. From that point easterly to the east terminus the North Route is immediately north of and parallel to the present highway with a separation at the Valley Creek Road. Through the valley a system of frontage road north of the Interstate will be required to provide access to the farms now served by the present highway.

SOUTH ROUTE

The South Route extends southeasterly from the west terminus to the top of the bluff east of Columbus where an interchange is proposed. From this interchange approximately one thousand feet north of the present highway, the route extends through the hills to Hensley Creek. At this point the route emerges from the hills and remains at the base of the hills for several miles. In the vicinity of Allen Creek, the South Route leaves the valley and climbs over two rocky bluffs before returning to the present highway. From this point to Park City the South Route is north of and parallel to the present highway with an interchange at Tilden Creek and a separation at Valley Creek. Through this eastern part of the valley, a system of frontage roads north of the Interstate will be required to provide access to the farms which are now served by the present highway.

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GEOLOGY

A general evaluation of the soils and geology of the area was made. The lines were carefully examined on air photos and inspected on the ground. The geology of this area is relatively uncomplicated. Although they will not negate any of the proposed lines, the soils and geology must be taken into account in comparing the various lines. A general description of the geology and soils, below, is followed by a more detailed analysis of each line, and a comparison of the alternates.

The upper Cretaceous sedimentary rocks exposed in the area are nearly flat-lying despite several relatively large structures --- few dips of more than 7° were measured. Thin gravel terraces capping flat-topped ridges at elevations of 3700 to 3800 feet in the eastern part of the area are remnants of glaciation. Deposits of gravel occur along both sides of the Yellowstone River and the river has created numerous steep bluffs along the valley. The river-developed topography has a decided effect on lines adjacent to the river.

The major formations exposed in the area are shown graphically and described in the chart. The most noticeable "local" feature is the thinness of the Bearpaw shale.

The development of the soils in the area varies with both bedrock type and topography. The uplands have a thin soil cover with numerous outcrops of Hell Creek sandstone. On ridge tops, the numerous flats developed on local sandstone beds attest to the thinness of the soil. In the large gullies, there are accumulations of slope debris, but even here the soils are not thick. The soils are derived from shales and soft sandstones of the Hell Creek formation with numerous pieces of soft to medium-hard angular sandstone gravel; their classification is generally A2-4 to A-4. The area covered by glacial gravel has little soil cover.

The soils along the valley are very different from the upland soils and much more pertinent to the selection of a line. In general, they are composed of the finer - and more deleterious - ingredients of the bedrock. Classifications range from A2-4 under bluffs to A6(12) in swampy areas. Although river deposits of gravel may underlie much of the area, they are exposed in only a few places and elsewhere have little apparent effect on valley soil development.

Both surface and subsurface drainage in the uplands are generally good. The lowland soils, however, have low permeability which results in poor subsurface drainage. Lowland surface drainage is generally fair, but for some areas the combination of railroad and highway embankments results in poor surface drainage. Drainage is complicated by irrigation of fields adjacent to the roads.

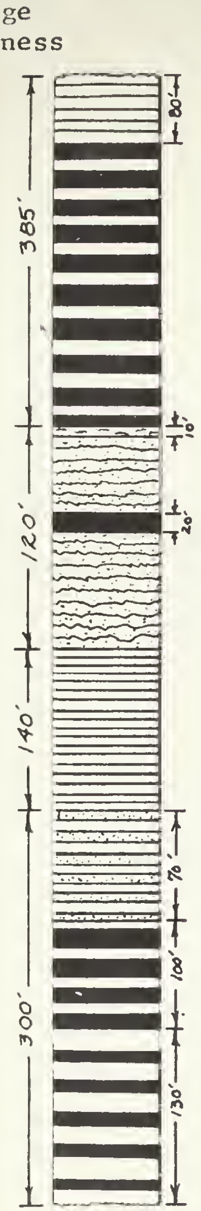
Effect of Geology and Soils on Alternate Lines

The material originating in the major cuts on these lines will make satisfactory embankment.

The Judith River formation starting at Station 1040, with the exception of a short section of Bearpaw shale (Stations 1058 to 1065), remains in Judith River to Station 1263; a thin gravel cap (10-20 feet) occurs on ridge tops from Station 1215 to 1240. The line traverses what is apparently a very gentle fold so that from

Generalized Cretaceous Sedimentary Rock Sequence

(top not found in area)



Thick sandstone with minor shale beds Alternating sandstone-shale	Hell Creek Formation	Alternating andesitic sandstone separated by beds of yellow, buff and dark green shales. Beds are competent when properly designed for back slope. Total thickness of the Hell Creek Formation is over 2000 ft.
Green shaly sandstone Alternating sandstone-shale Massive sandstone bed Alternating sandstone-shale	Lennep Formation	Formation thickness in area 120'(90'-160'). Dark sandstone with yellow, green, and grey shale. Limonite cement weathers light to very dark brown. Sandstone forms sharp escarpments between shale soil slopes. Beds are competent when cut slopes are properly designed.
Shale with minor sandstone beds	Bearpaw Shale Formation	Formation thickness in area 140'(120'-160'). Soft, grey, slightly sandy shale with interbedded lenses of thin sandstone beds. Backslopes require special design.
Predominately shale with thin sandstone beds. Alternating massive sandstone and shale beds Alternating sandstone and shale beds	Judith River Formation	Approximately 300' of Judith River Formations is exposed in the area east of Columbus. Grey to brown sandstone interbedded with yellow, green and black shales. Formation weathers buff to light brown. Shales weather readily from beneath competent sandstone, producing rock falls.

(bottom not found in area)

Station 1090 to 1140 is nearly a dip slope on the thick sandstone bed in the upper Judith River formation. The section from Station 1140 to 1200 also appears to be a dip slope, but the sandstone bed has split into several beds with shale between. There will be a large cut at Station 1216, which should be designed with the same consideration for shale stability as in the cuts west of Columbus. There are no apparent foundation stability problems on this line.

ESTIMATING PROCEDURE

Grading Costs

Aerial photos of the study area were taken by the Montana Highway Commission to prepare contour maps. From these contour maps alternate routes were selected for study. Ground profiles and cross-sections were obtained from the contour maps, and grade lines were plotted on profile sheets. By entering grade data, backslope data, and typical sections in the IBM 1620 electronic computor, volumes of cut and fill for each route were computed and tabulated electronically.

Rock percentages in the major cuts were estimated from field studies conducted by the Montana Highway Commission geologists. Mass diagrams were plotted and used to estimate lengths of haul for each line. Blasting percentages and haul conditions were the primary factors affecting unit costs for earth quantities on each route.

Costs of clearing and grubbing, as well as watering and rolling costs, were estimated from average bid prices for similar jobs. Frontage road costs were estimated on state wide average per mile costs for the type of road.

Drainage

The costs of drainage structures 72" or less in diameter were based on average costs per mile. The costs of drainage pipes over 72" in diameter were estimated individually.

Base and Surfacing

Unit costs per mile for base and surfacing were estimated by correlating bid prices paid on a similar job to the typical section used in this study. Total costs for base and surfacing were in direct proportion to the length of each route.

Separations and Interchanges

Costs for separations and interchanges were estimated by adding separate costs for structure, grade and drain, base and surfacing, curbs and rails, and traffic control. Structural costs were estimated on average costs per square foot of deck area for the type of structure considered. Terrain features were considered in estimating costs for grading and drainage. Other items were estimated on the basis of average prices paid for similar installations built on the Interstate System in Montana.

Utility Adjustments

Each line was studied to determine utilities lying in the zones of construction. Utilities that needed to be moved were power, telephone, and telegraph poles. Costs for moving were figured on average unit costs per pole for each type of pole.

Miscellaneous

Miscellaneous costs were included for guardrail, fencing, and traffic control. Guardrail was included wherever fills existed that were greater than 10 feet in depth. Costs for fencing and traffic control were included at the current average per mile bid prices.

Engineering and Contingencies

The cost of engineering is estimated to be 6% of the cost of construction items. The minor items not specifically included in the estimate are included in the contingencies and are estimated to be 10% of the costs of the construction items.

TABLE NO. 1

ESTIMATED CONSTRUCTION COST

NORTH LINE

ITEM	UNIT	UNIT COST	QUANTITY	SUBTOTAL	TOTAL
Utility Adjustments	Lump Sum	$		$	$ 5,028
Grade and Drain					3,478,533
Grade Mainline	Cu. Yds.	0.546	5,471,947	2,987,683	
Grade Frontage Roads	Mile	17,700	2.569	45,471	
Minor Drainage	Mile	11,700	15.862	185,585	
Major Drainage	Lump Sum			94,395	
Stock Passes	Lump Sum			45,471	
Clearing & Grubbing	Acre	3,175	37.30	118,428	
Channel Change	Cu. Yd.	0.30	5,000	1,500	
Base & Surfacing					2,061,164
Mainline	Mile	128,000	15.862	2,030,336	
Frontage Roads	Mile	12,000	2.569	30,878	
Highway Separations	Lump Sum				154,954
Interchanges	Lump Sum				718,706
Miscellaneous					230,948
Guardrail	Foot	2.50	39,000	97,500	
Fencing	Mile	3,600	15.862	57,103	
Traffic Control	Mile	400	15.862	6,345	
Rest Area	Lump Sum			70,000	
Construction Items					6,649,333
Engineering	6%				398,960
Contingencies	10%				664,933
Right of Way	Lump Sum				181,600
TOTAL					$7,894,826

TABLE NO. 2

ESTIMATED CONSTRUCTION COST

SOUTH LINE

ITEM	UNIT	UNIT COST	QUANTITY	SUBTOTAL	TOTAL
Utility Adjustments	Lump Sum	$		$	$ 16,315
Grade and Drain					2,478,325
Grade Mainline	Cu. Yd.	0.462	4,356,531	2,012,717	
Grade Frontage Roads	Mile	17,700	5.761	101,970	
Minor Drainage	Mile	11,700	16.915	197,906	
Major Drainage	Lump Sum			41,184	
Stock Passes	Lump Sum			101,218	
Clearing & Grubbing	Acre	3.175	6.88	21,844	
Channel Change	Cu. Yd.	0.30	4,954	1,486	
Base & Surfacing					2,234,252
Mainline	Mile	128,000	16.915	2,165,120	
Frontage Roads	Mile	12,000	5.761	69,132	
Highway Separations	Lump Sum				154,954
Interchanges	Lump Sum				718,706
Miscellaneous					209,660
Guardrail	Foot	2.50	28,800	72,000	
Fencing	Mile	3600	16.915	60,894	
Traffic Control	Mile	400	16.915	6,766	
Rest Area	Lump Sum			70,000	
Construction Items					5,812,212
Engineering	6%				348,733
Contingencies	10%				581,221
Right of Way	Lump Sum				201,300
TOTAL					$6,943,466

TABLE NO. 3

ANNUAL CONSTRUCTION COST

ITEM	LIFE	NORTH LINE		SOUTH LINE	
	YEARS	TOTAL	ANNUAL	TOTAL	ANNUAL
Utility Adjustments	40	$ 5,028	$ 334	$ 16,315	$ 1,084
Grade & Drain	40	3,478,533	231,322	2,478,325	164,809
Base & Surfacing	20	2,061,164	179,733	2,234,252	194,827
Highway Separations	50	154,954	9,824	154,954	9,824
Interchanges	30	718,706	52,178	718,706	52,178
Miscellaneous	20	230,948	20,139	209,660	18,282
Engineering	30	398,960	28,964	348,733	25,318
Contingencies	30	664,933	48,274	581,221	42,197
Right of Way	50	181,600	11,513	201,300	12,762
TOTAL		$7,894,826	$582,281	$6,943,466	$521,281

6% CRF
20 = .0872
30 = .0726
40 = .0665
50 = .0634

MAINTENANCE COSTS

Table No. 4 shows annual maintenance costs that were estimated for each route.

Maintenance costs for the 4-lane Interstate highway were estimated on the basis of $3,000 per mile. An extra annual cost of $500 per mile was included for sanding and snow removal on Interstate sections involving steeper grades.

Maintenance costs for frontage roads were estimated on the basis of $1,500 per mile.

The table indicates that the annual maintenance cost of the North Line is $7,407 less than the South Line.

TABLE NO. 4

ANNUAL MAINTENANCE COSTS

ROADWAY	Cost Per Mile	NORTH LINE		SOUTH LINE	
		Miles	Cost	Miles	Cost
Interstate	$3,000	15.862	$47,586	16.915	$50,745
(Extra Sanding)	500	2.311	1,156	1.231	616
Frontage Roads	1,500	2.569	3,854	5.761	8,642
TOTAL			$52,596		$60,003

OPERATOR'S COSTS

Operator's costs, commonly referred to a road user costs, are all costs associated with owning and operating a motor vehicle. Road user costs include costs for investment, time, fuel, oil, and all maintenance items; and are calculated in terms of unit costs per vehicle-mile of travel. These unit costs depend upon the type of vehicle considered, and upon road features such as curvature, percent grades, and conditions of road surfaces. Travel speeds also bear a relationship to vehicle operating costs.

In making a route study a comparison must be made between total road user costs that will be associated with each route. In computing road user costs, one must consider operating costs for traffic using any road that will be affected by an alternate route.

Costs for operating vehicles on roads in the Columbus vicinity were calculated separately for cars and trucks.

For vehicles using the Interstate Highway, unit costs were divided by separating unit costs on the basis of per cent of grade. The following table shows per mile costs used in computing road user costs for this report.

ROAD CLASSIFICATION	CARS	TRUCKS
Four-Lane Interstate	$0.0977 (0-3%) 0.1015 (3-5%)	$0.2778 (0-1%) 0.2791 (2%) 0.3066 (3%) 0.3464 (4%) 0.3966 (5%)

A weighted average based on these costs is shown in Table No. 5.

In computing road user costs, it is necessary to know the average daily traffic volumes that will pertain to each road affected by an alternate route. Traffic counts as well as origin and destination data were taken at Columbus by the Planning Survey Department of the Montana Highway Commission. From this data, it was possible to estimate average car and truck traffic volumes that could be expected on each road over a 20-year study period. Average annual vehicle-miles of travel on each road were computed by multiplying travel distances by annual traffic volumes. By applying appropriate car and truck unit costs to annual vehicle-miles of traffic, total annual costs on each road affected were computed.

TABLE NO. 5
ANNUAL OPERATING COSTS

FACILITY	LENGTH	AVERAGE DAILY TRAFFIC	ANNUAL VEHICLE MILES	COST PER MILE	ANNUAL OPERATING COST
North	15.862	3455	20,003,172	0.1314	$2,628,417
South	16.915	3455	21,331,084	0.1292	2,755,976

As noted previously, the most favorable alternate based on monetary considerations is the routing which has the lowest overall construction, maintenance, and operating costs. Table 6 shows that the North Line has a total annual cost of $74,000 less than the South Line.

TABLE NO. 6

TOTAL ANNUAL COST

ITEM	COST ($1,000) NORTH LINE	COST ($1,000) SOUTH LINE
Construction	582	521
Maintenance	53	60
Operating	2,628	2,756
TOTAL	3,263	3,337

In addition to the factors which have previously been discussed, several others which are more difficult to represent in monetary terms have been considered.

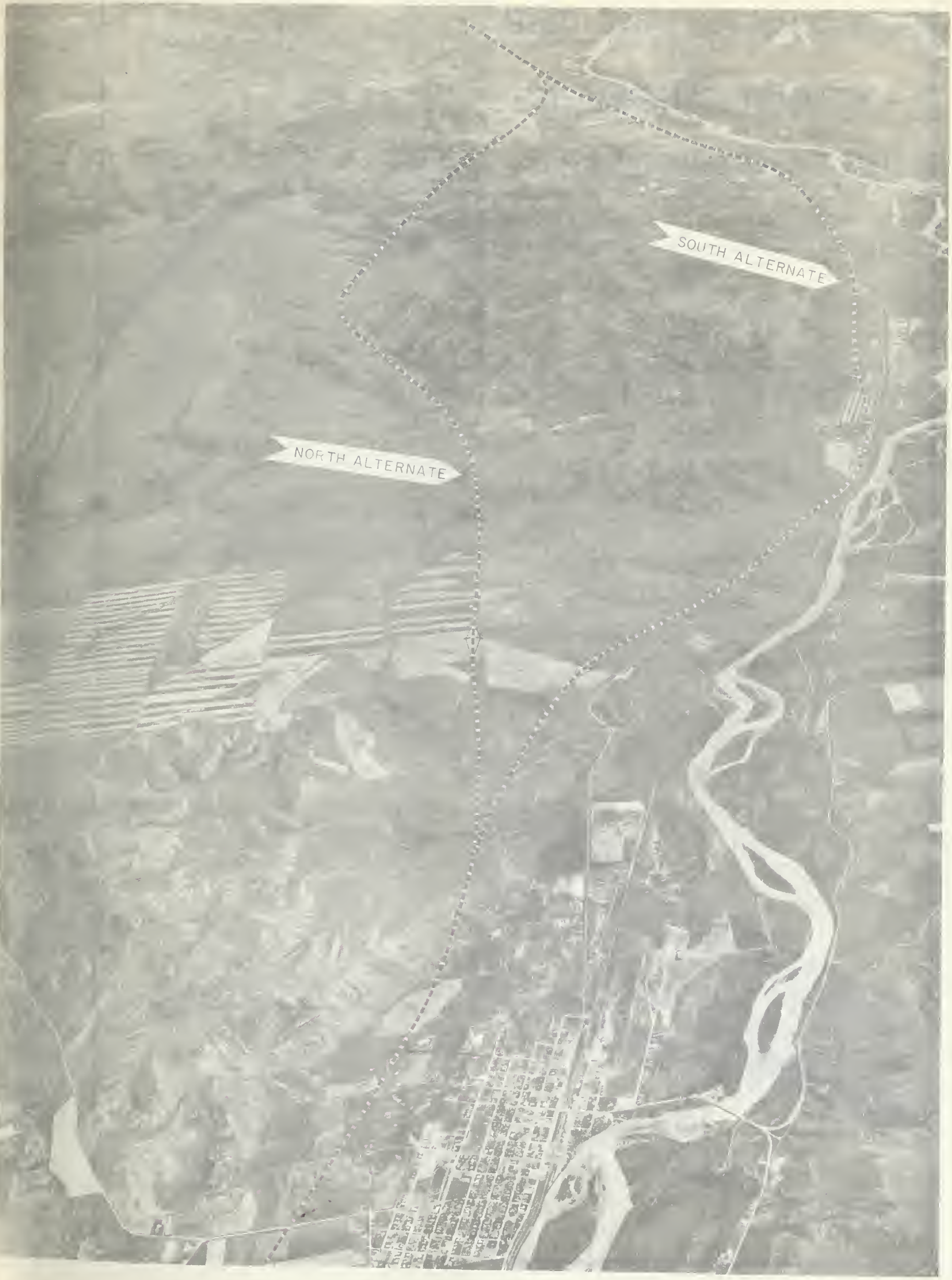
More of the North Line is constructed on land out of the cultivated land, than the South Line, therefore, causing less disruption to the agricultural development of the area.

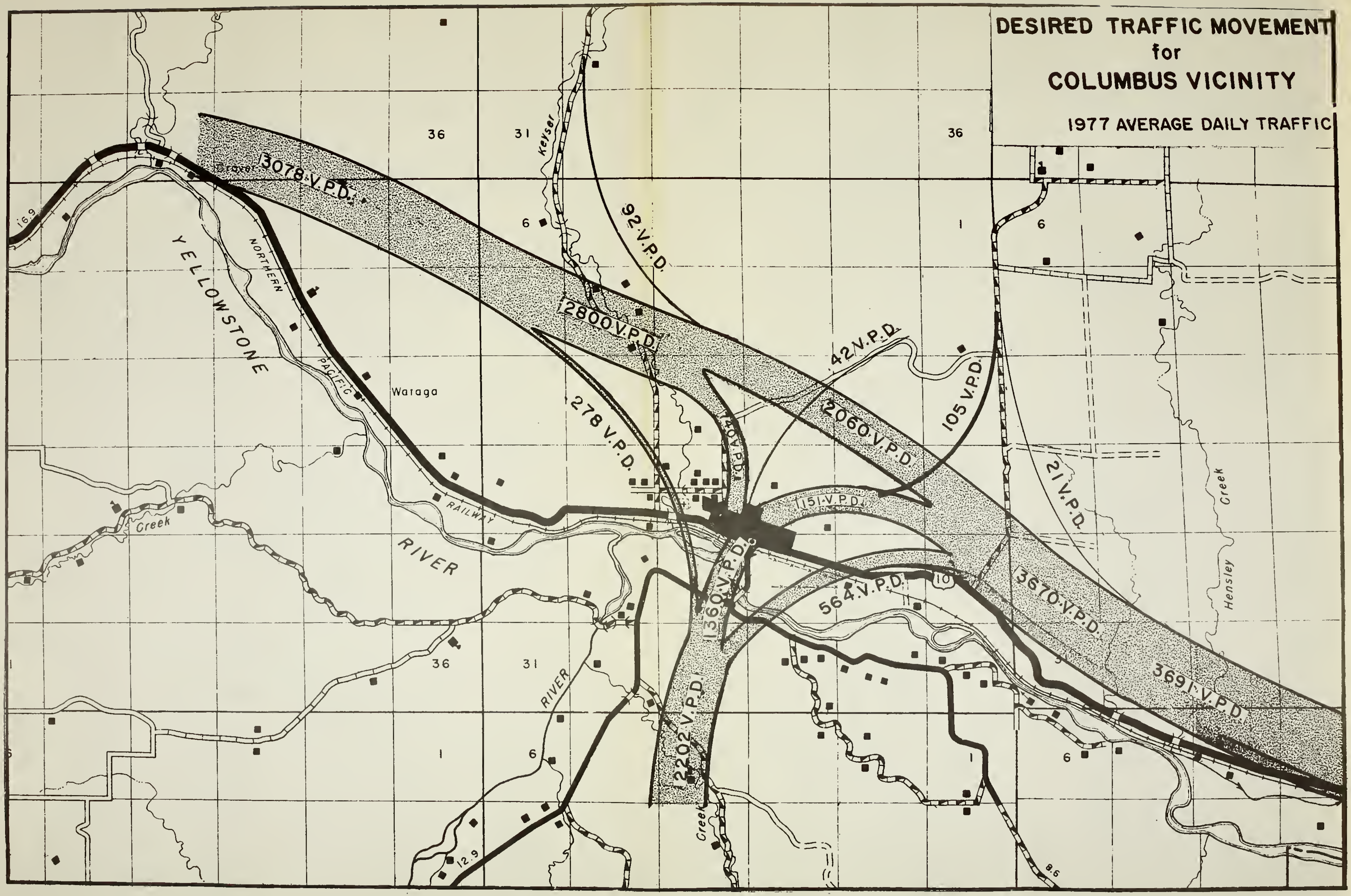
In the area from Columbus to Youngs Point, the South Line approximately parallels the present highway, which causes more disruption to the present traffic pattern than the North Line which traverses an uninhabited area. In addition to lengthening the travel distance to those persons whose access is directly affected, construction of the South Line would also lengthen the existing school bus, mail, and fire routes in this area.

The North Line met with almost unanimous approval of those present at the public hearing held in Columbus on October 6, 1964.

RECOMMENDATION

An analysis of all major routing criteria indicates that the North Line is the best alignment for Interstate 90 in this area and it is therefore recommended.

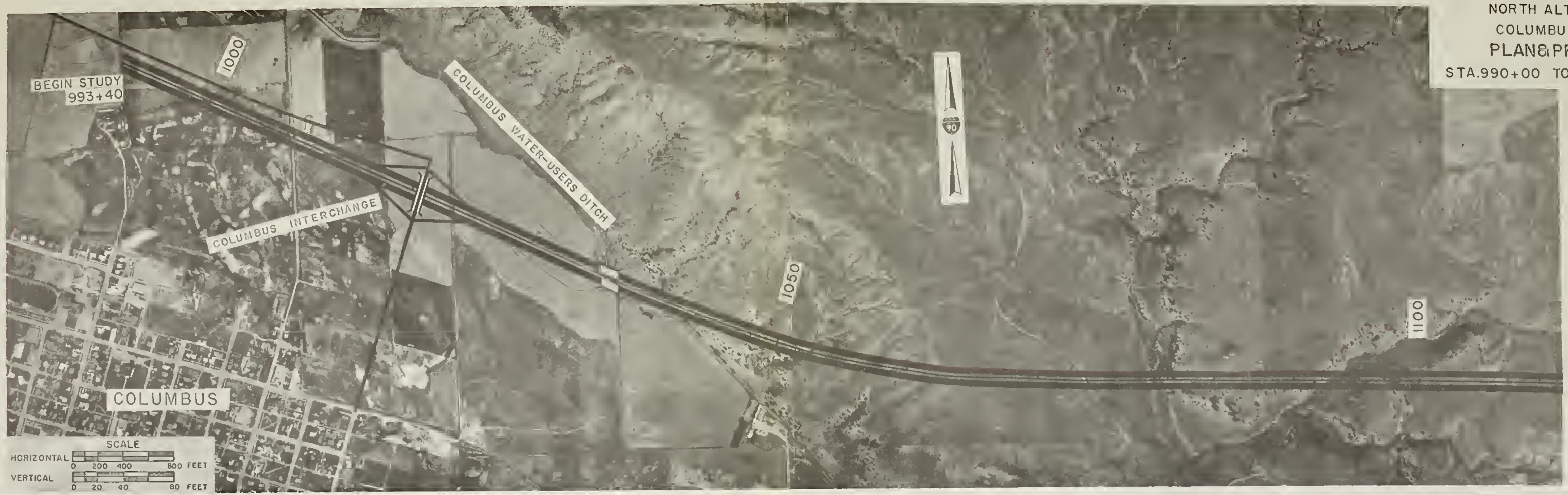

SOUTH ALTERNATE
NORTH ALTERNATE

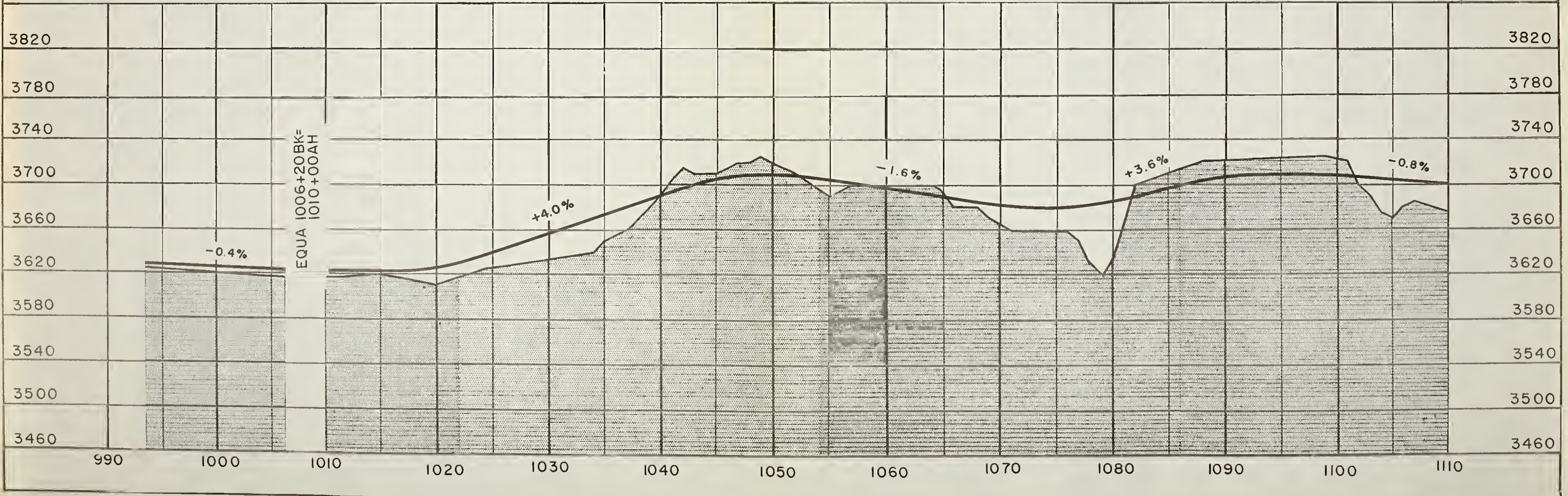


DESIRED TRAFFIC MOVEMENT for COLUMBUS VICINITY

1977 AVERAGE DAILY TRAFFIC

NORTH ALTERNATE
COLUMBUS-EAST
PLAN&PROFILE
STA.990+00 TO STA.1110+00





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PLAN & PROFILE
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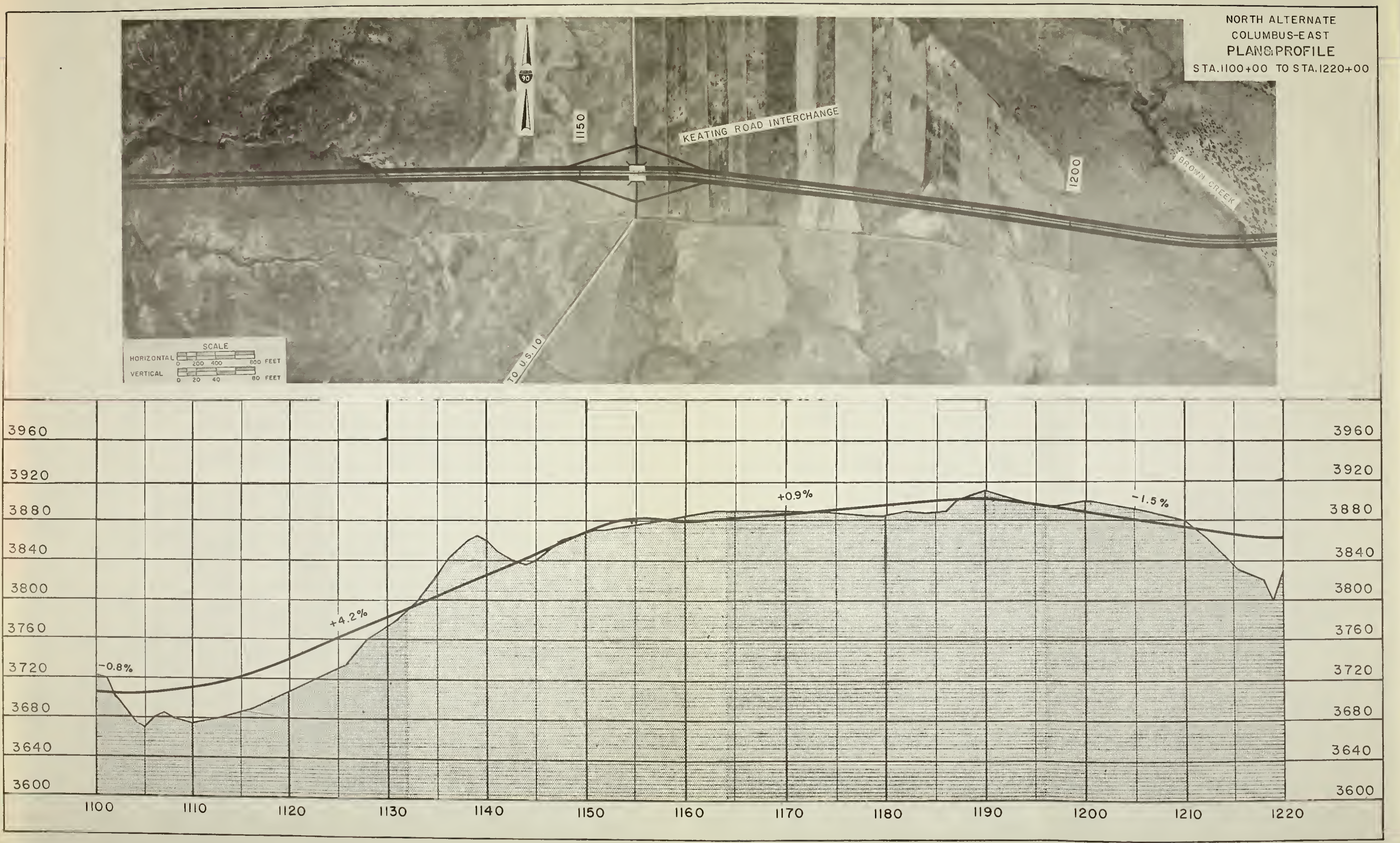

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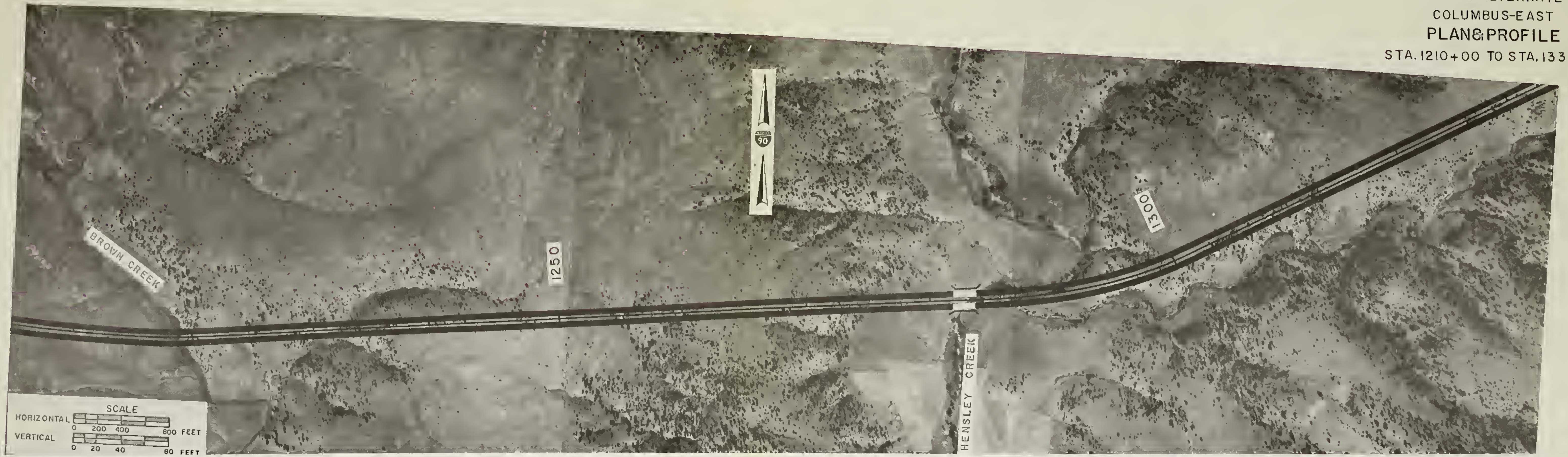

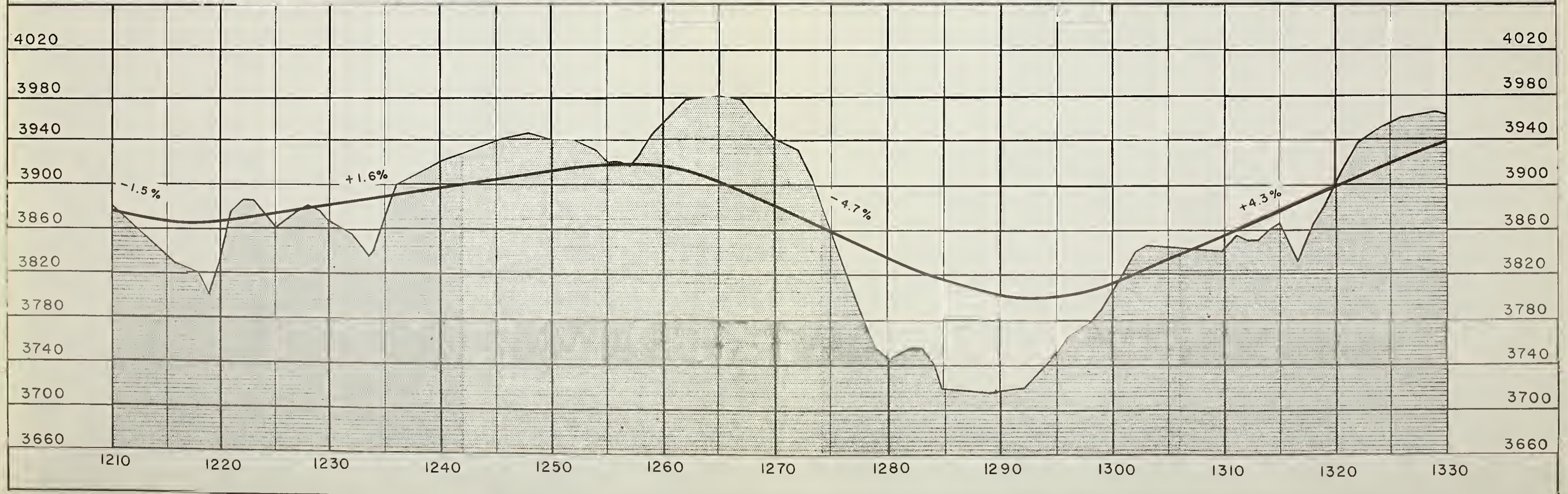

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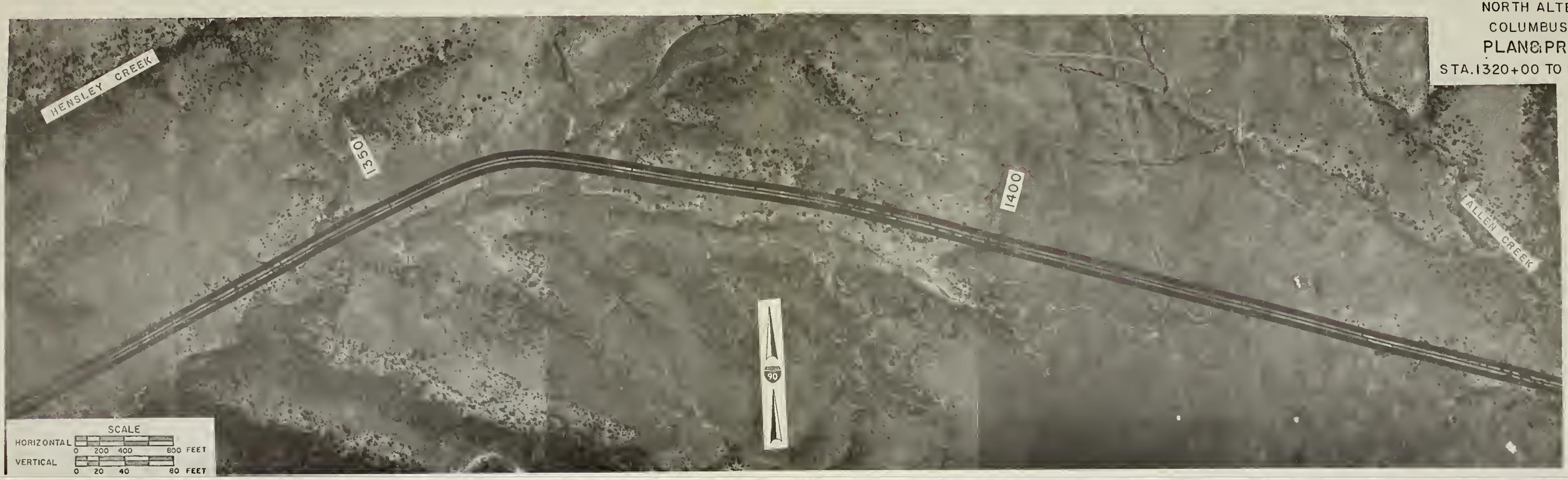

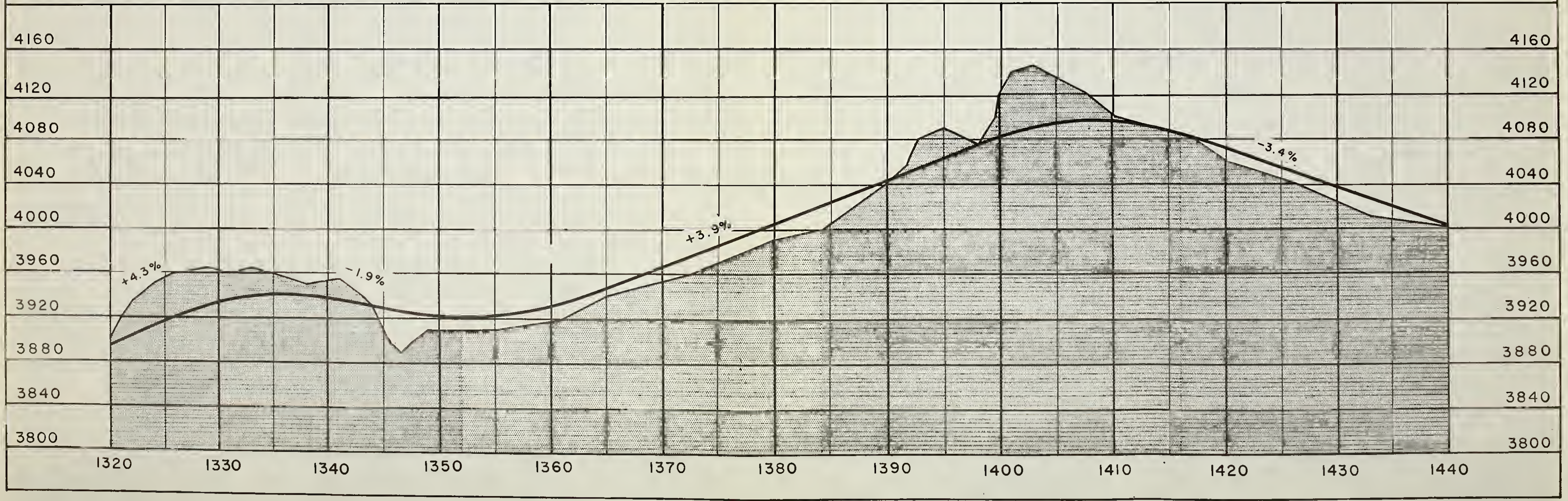

NORTH ALTERNATE
COLUMBUS-EAST
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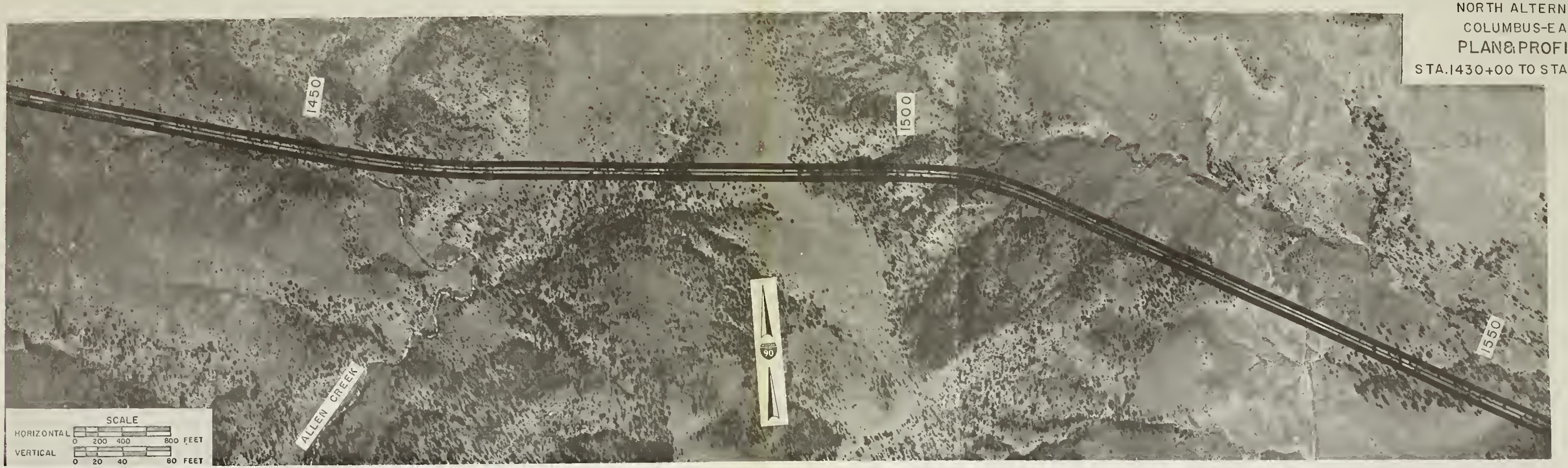

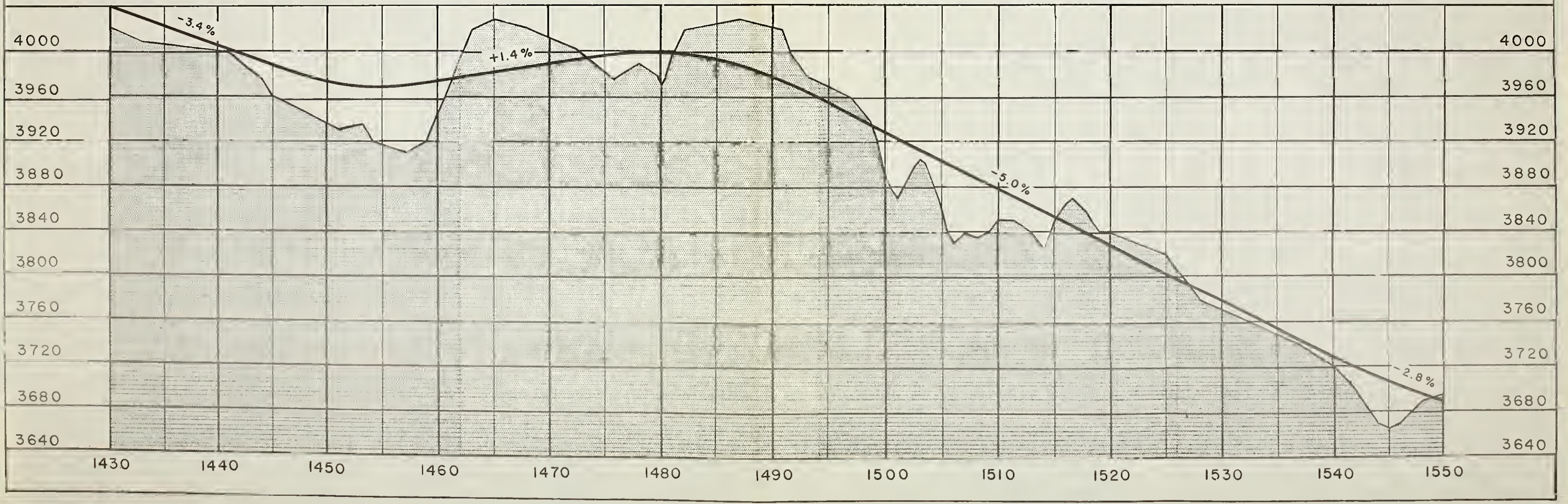

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COLUMBUS-EAST
PLAN & PROFILE
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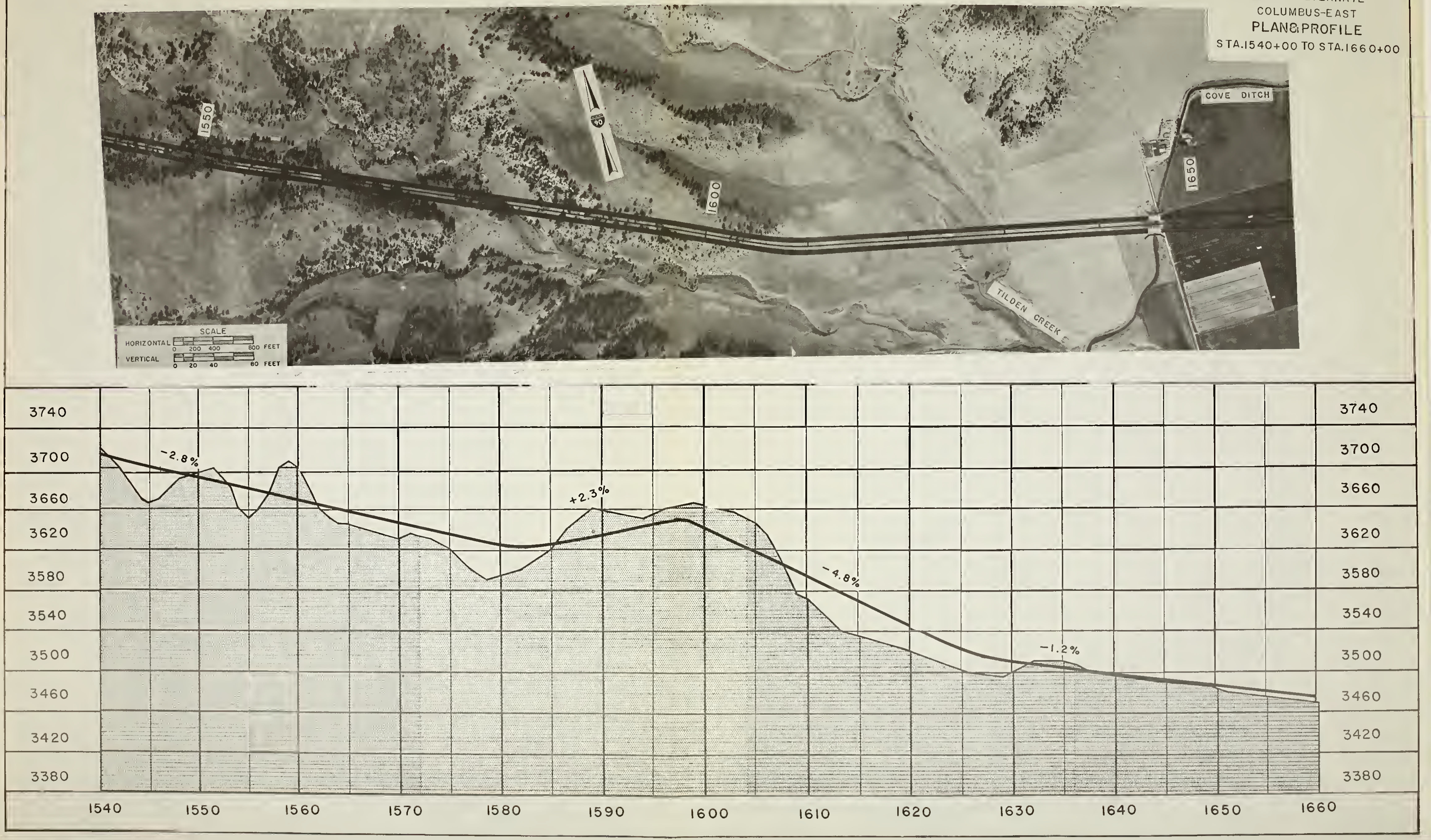

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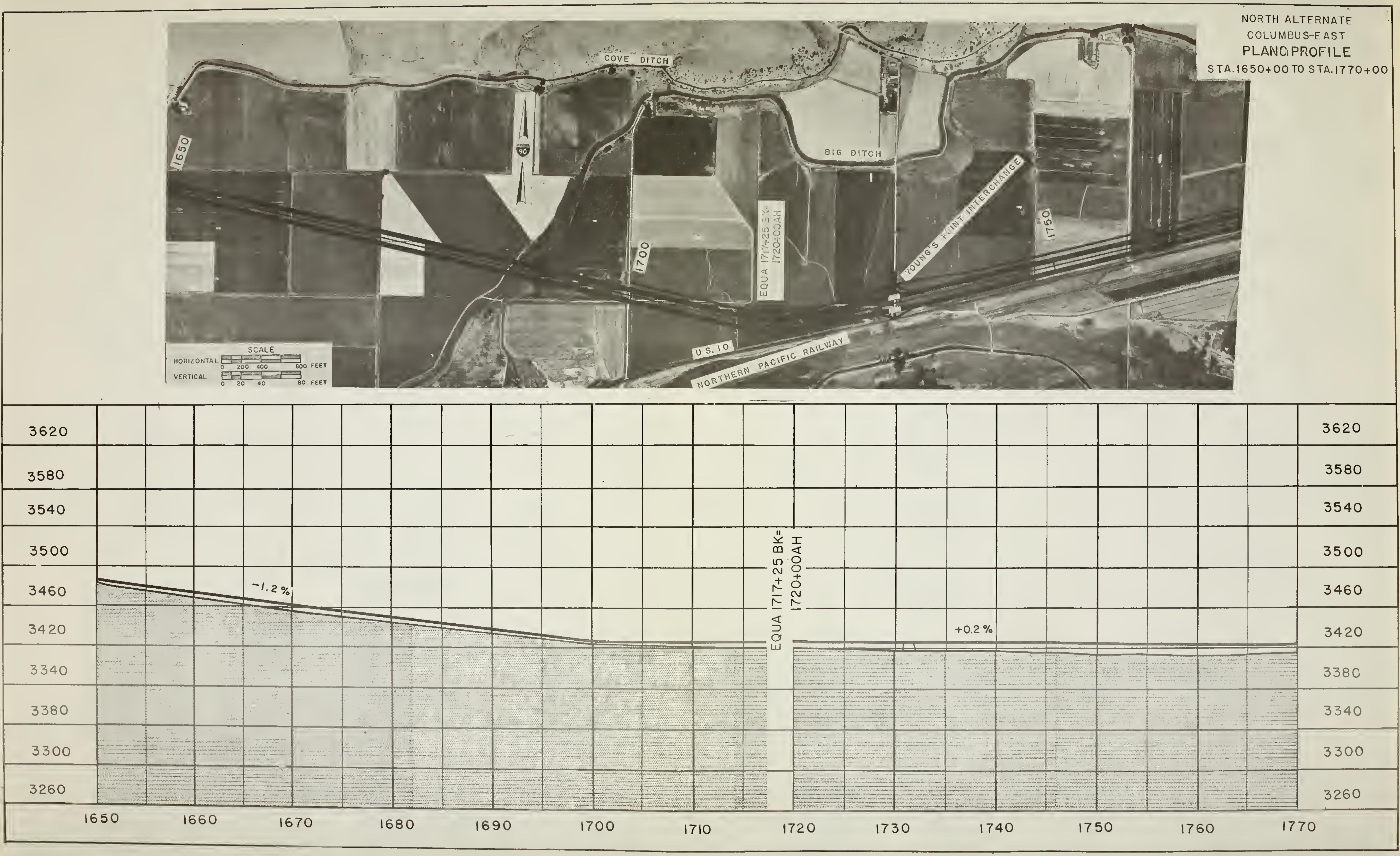

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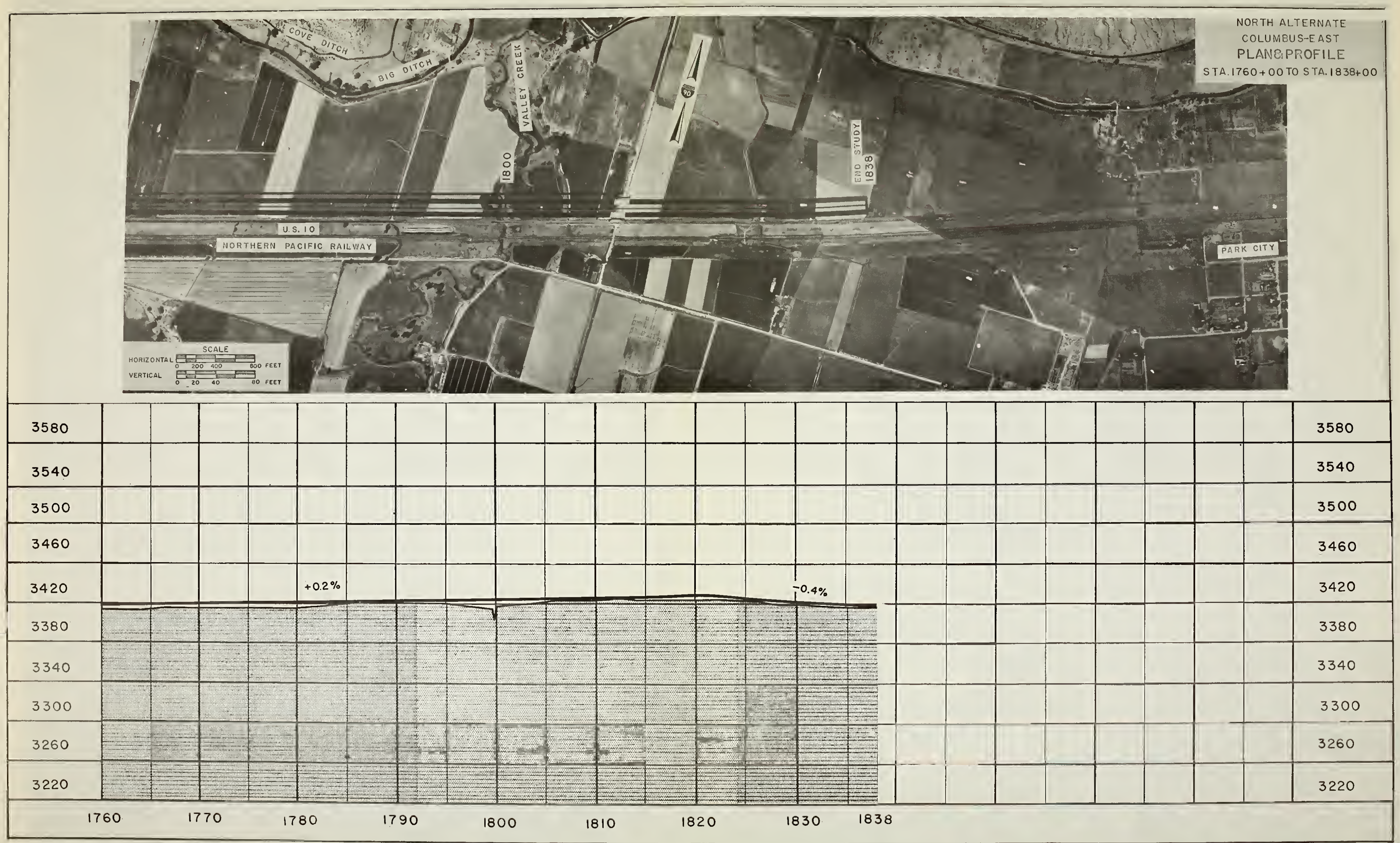
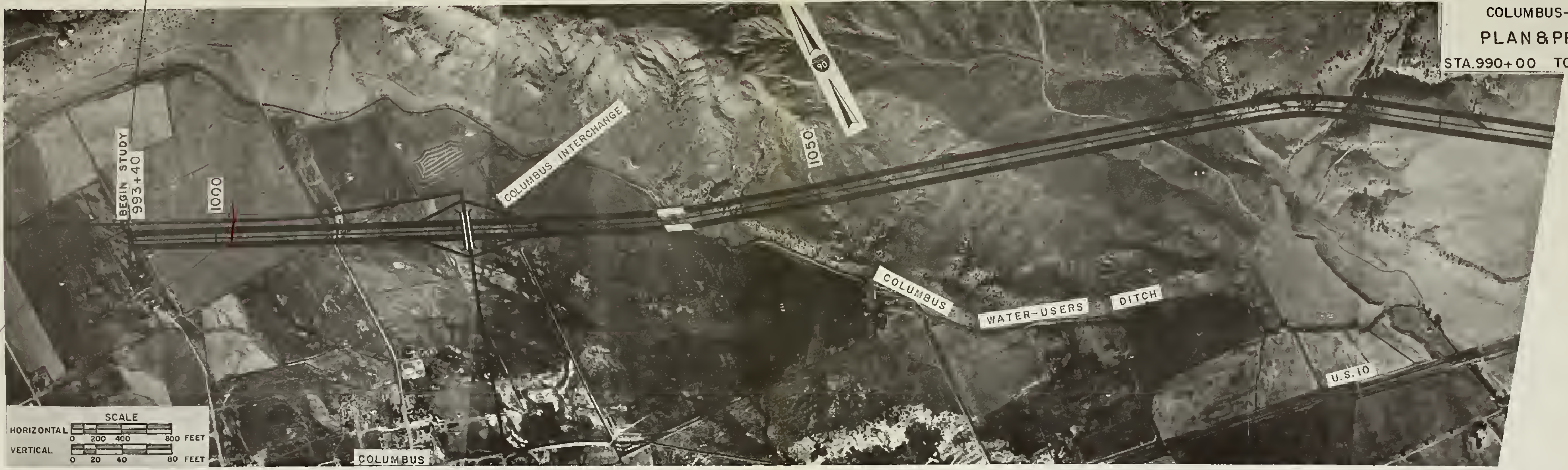
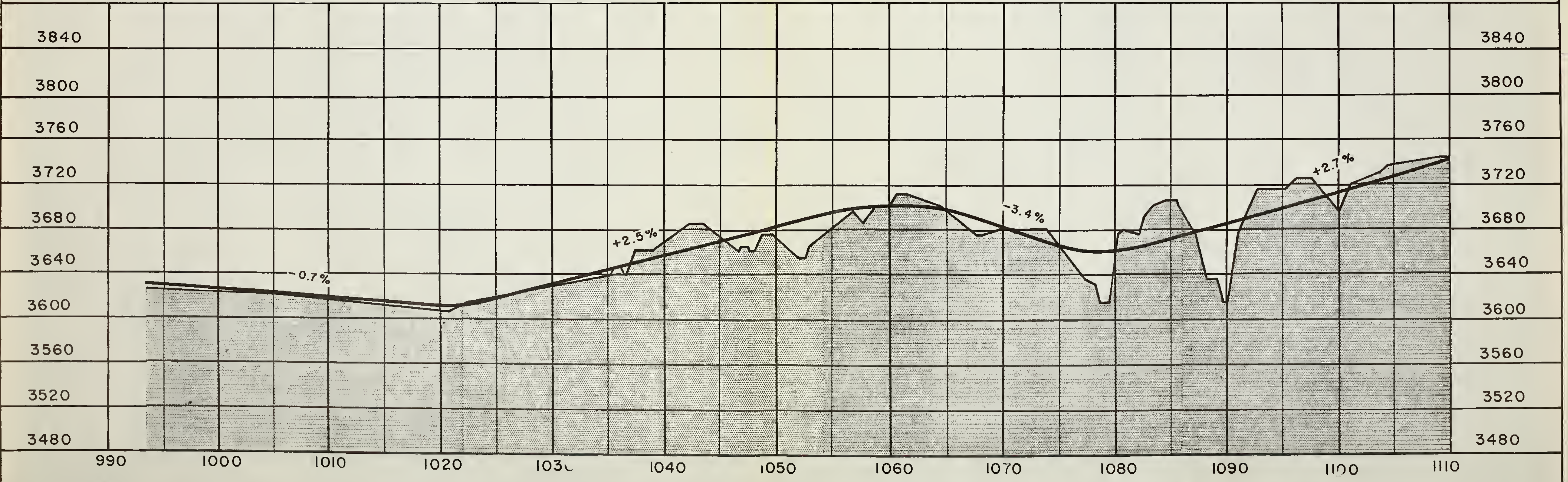


SOUTH ALTERNATE
COLUMBUS-EAST
PLAN & PROFILE
STA. 990+00 TO STA. 1110+00

965+95 A Back
=
993+40.9 Ahead

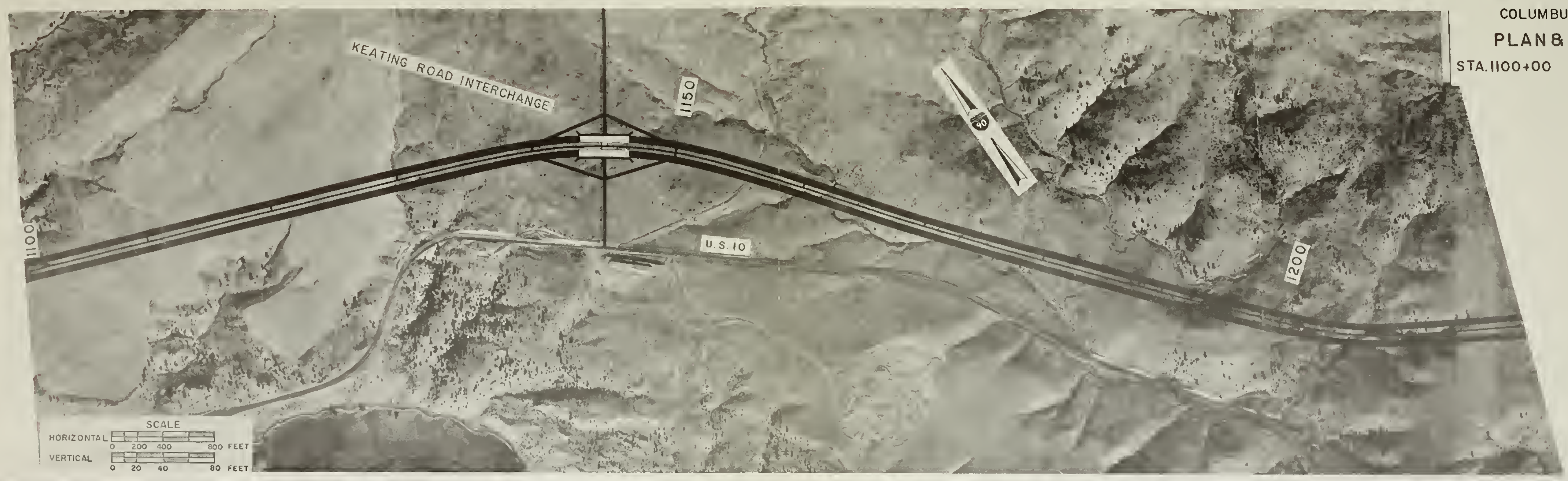


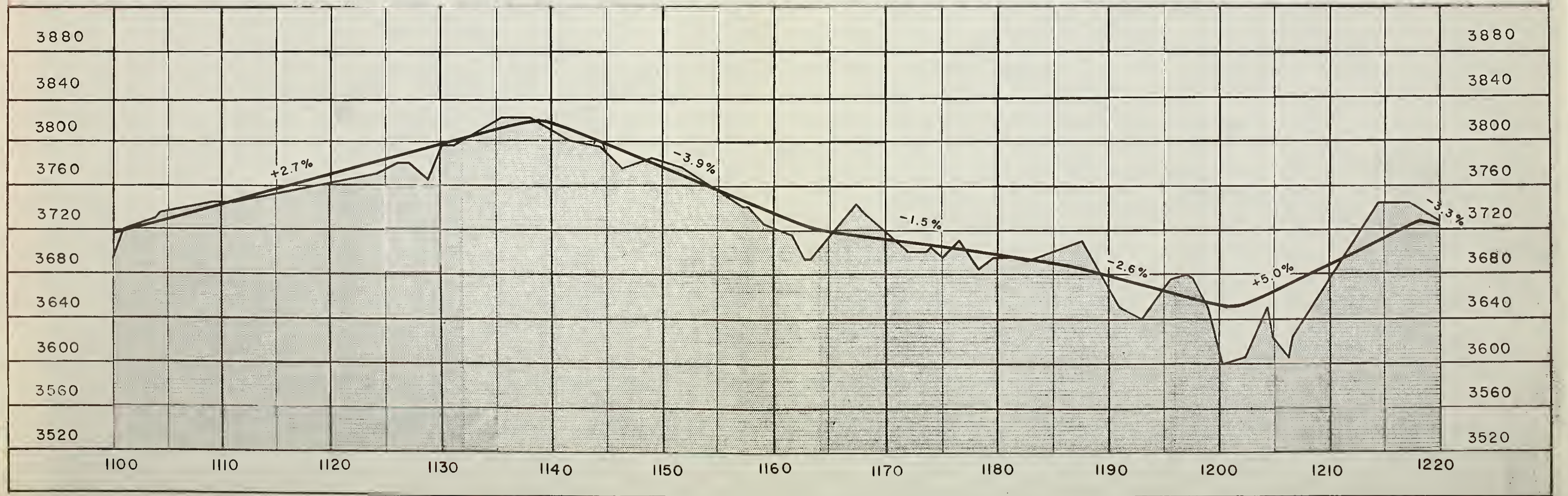


965+00

B

SOUTH ALTERNATE
COLUMBUS-EAST
PLAN & PROFILE
STA. 1100+00 TO STA. 1220+00





SOUTH ALTERNATE
COLUMBUS-EAST

PLAN & PROFILE

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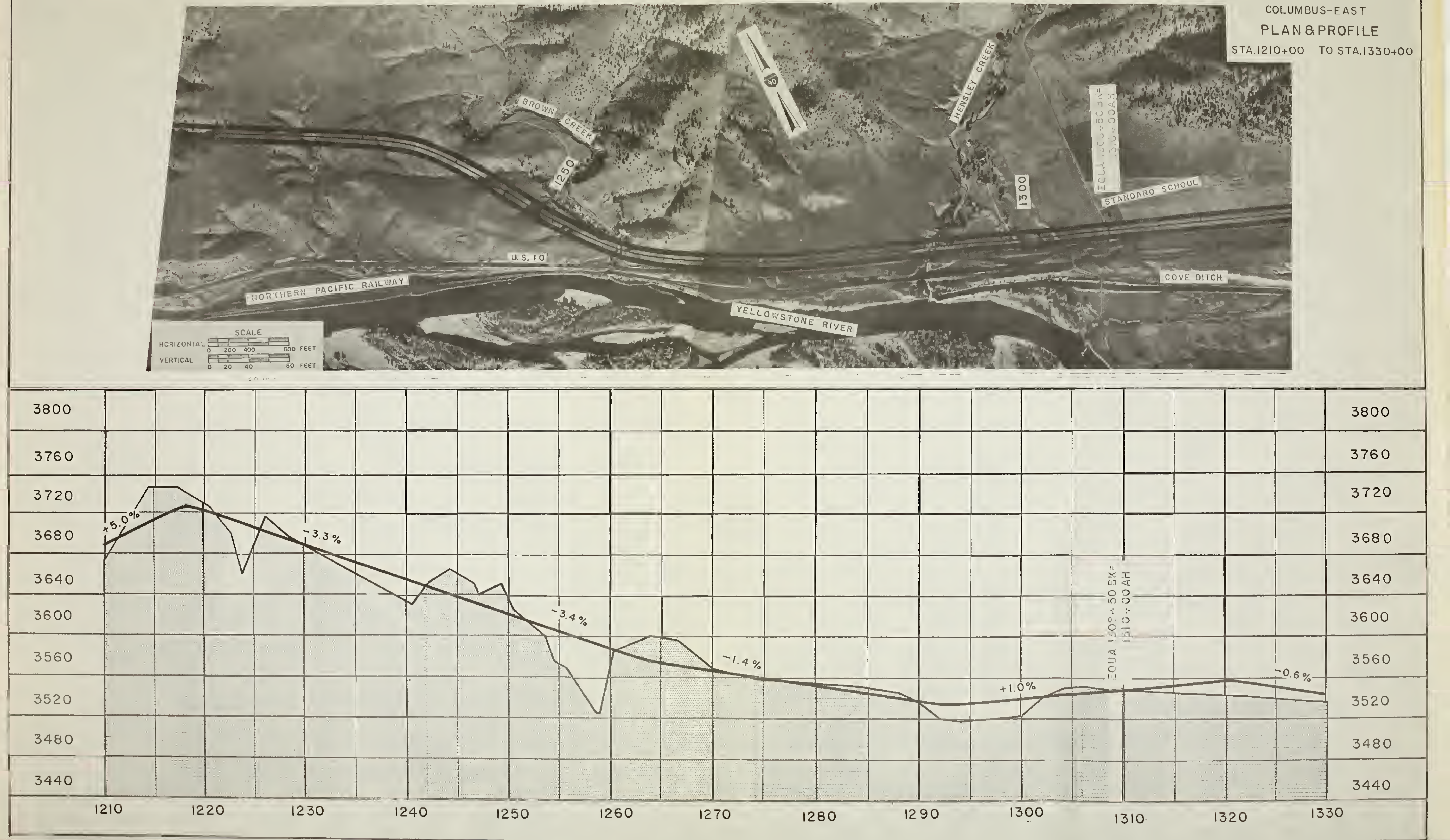
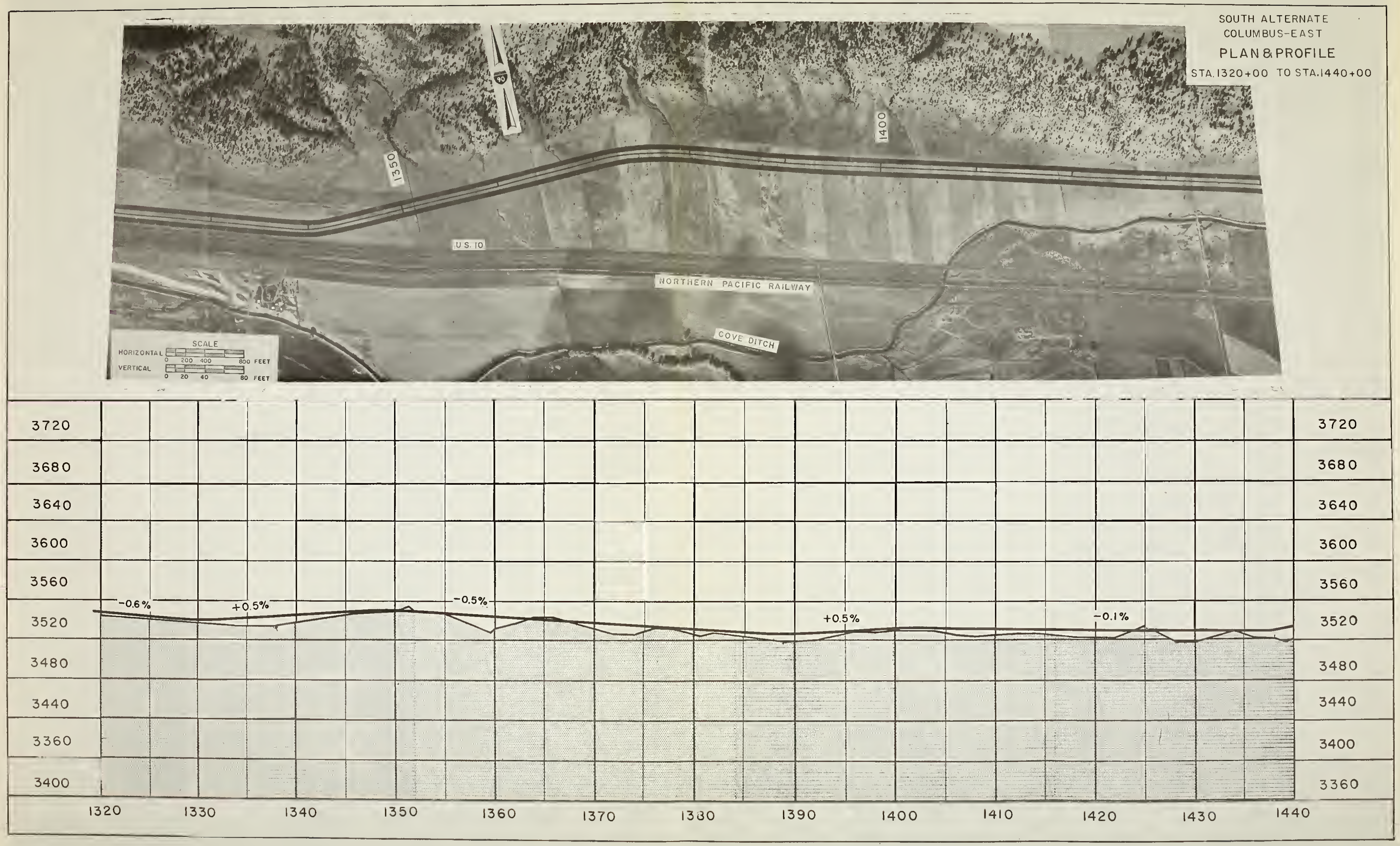


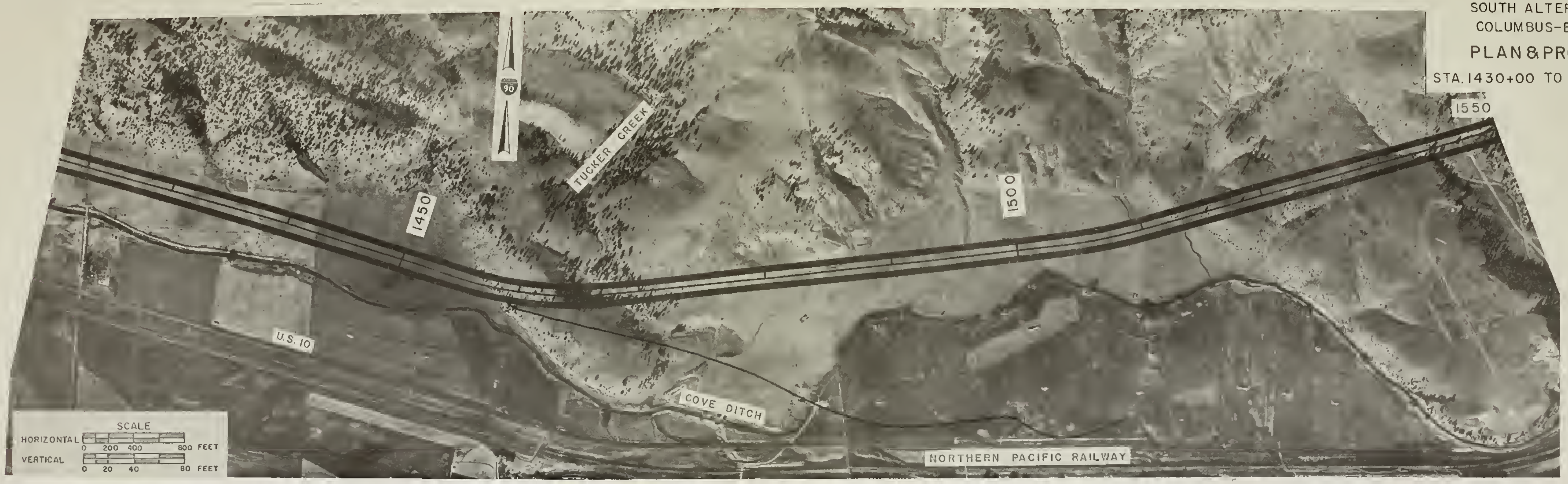
SOUTH ALTERNATE
COLUMBUS-EAST
PLAN & PROFILE
STA.1320+00 TO STA.1440+00

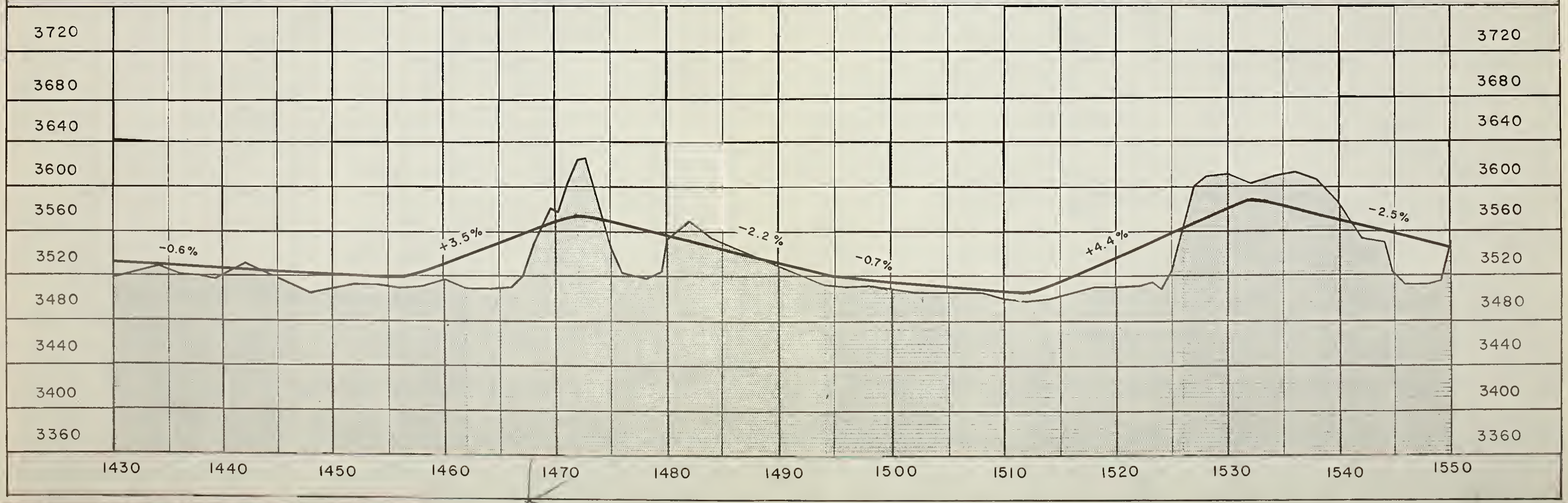


SOUTH ALTERNATE
COLUMBUS-EAST

PLAN & PROFILE

STA. 1430+00 TO STA. 1550+00

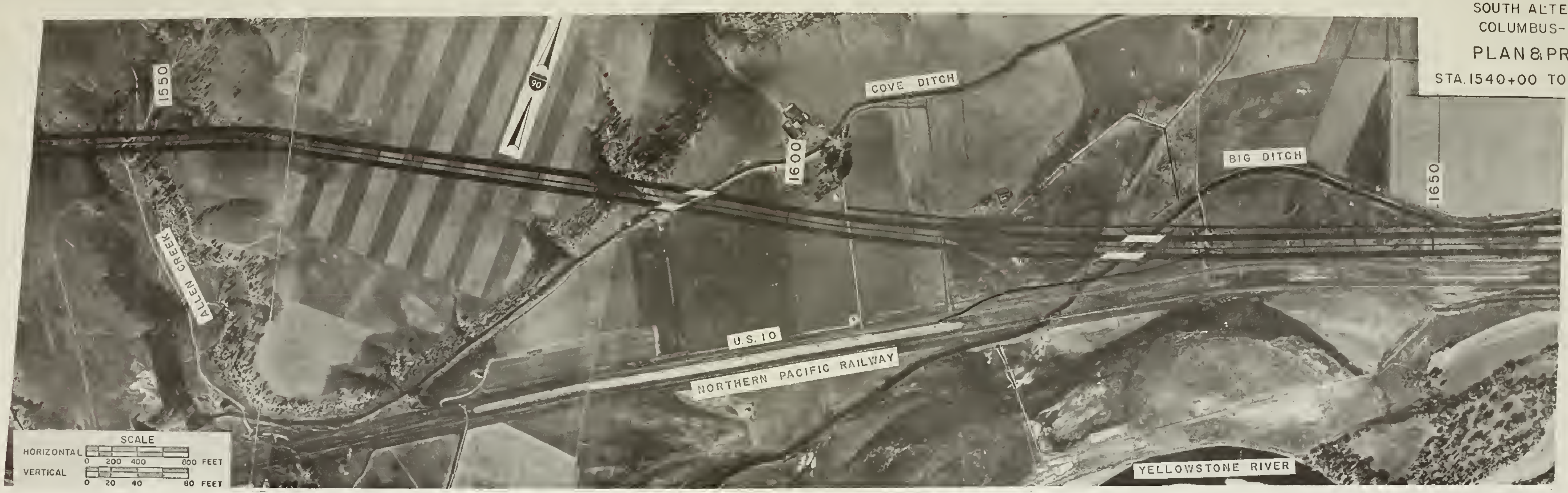


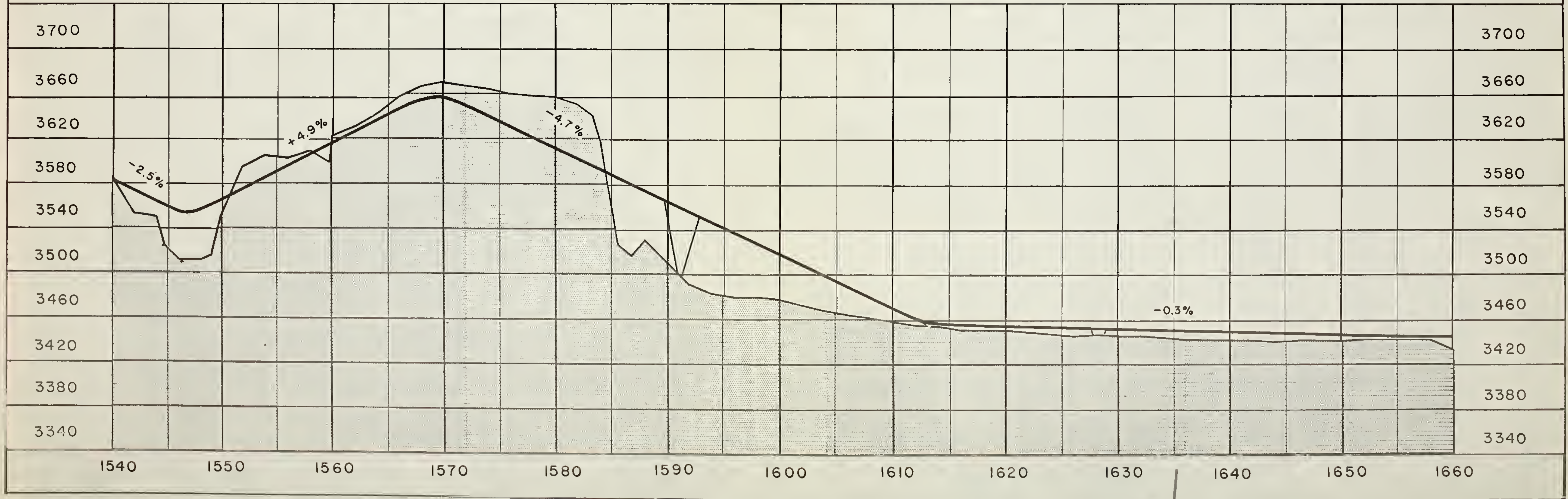


SOUTH ALTERNATE
COLUMBUS-EAST

PLAN & PROFILE

STA. 1540+00 TO STA. 1660+00

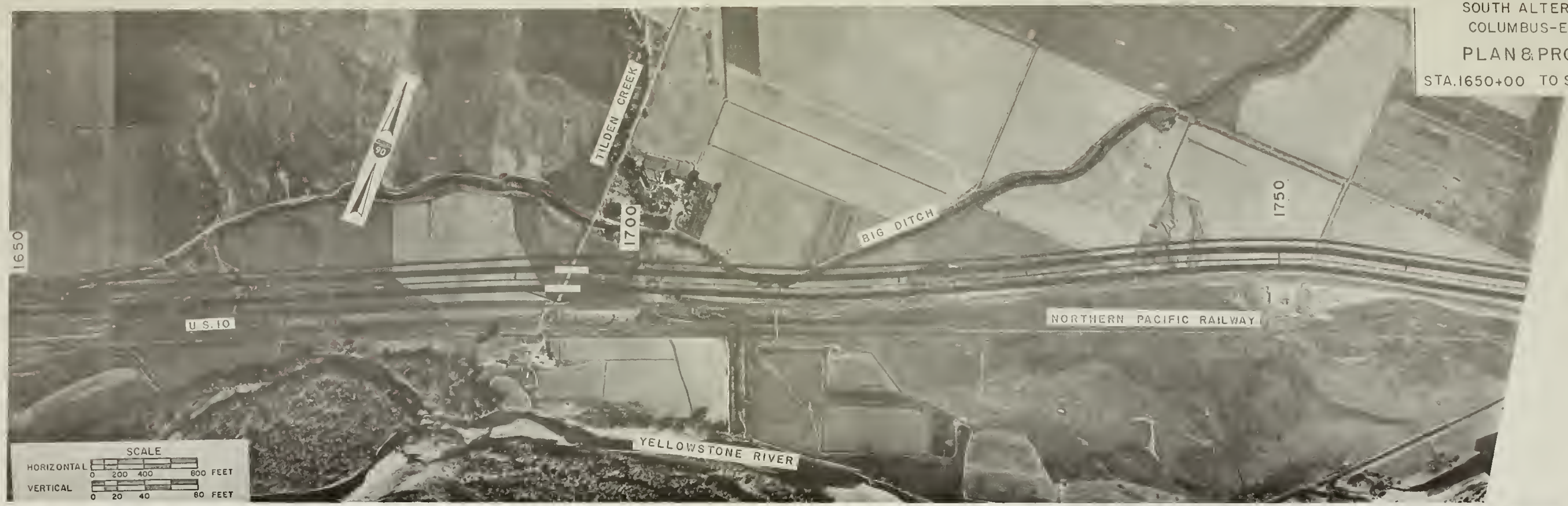


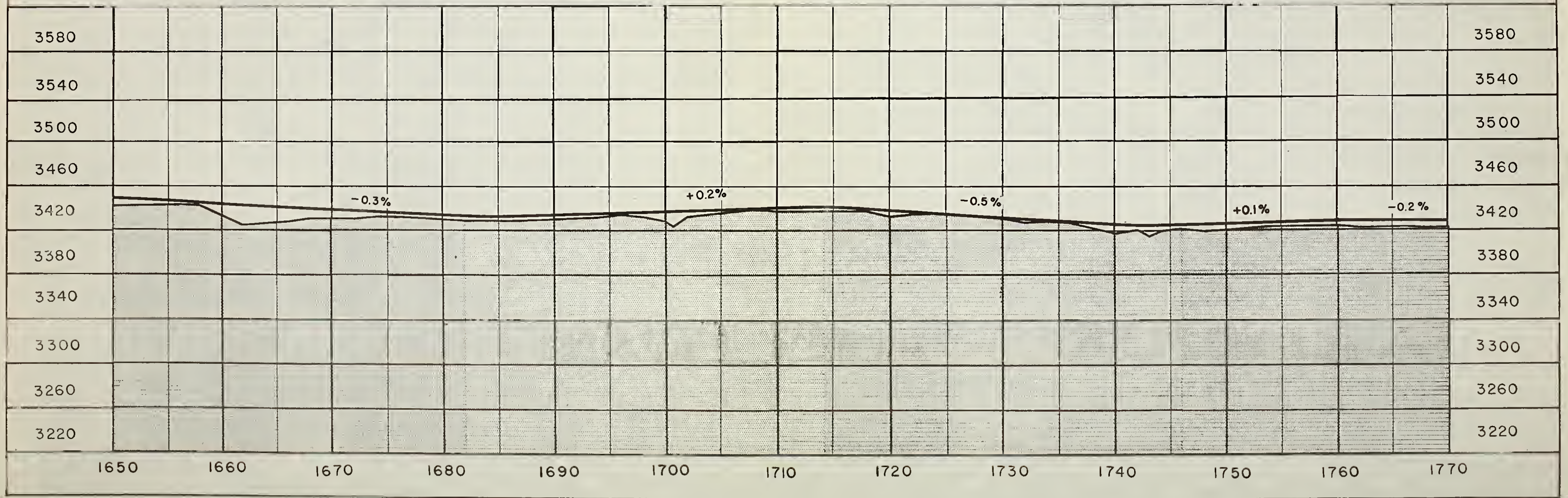


SOUTH ALTERNATE
COLUMBUS-EAST

PLAN & PROFILE

STA.1650+00 TO STA.1770+00

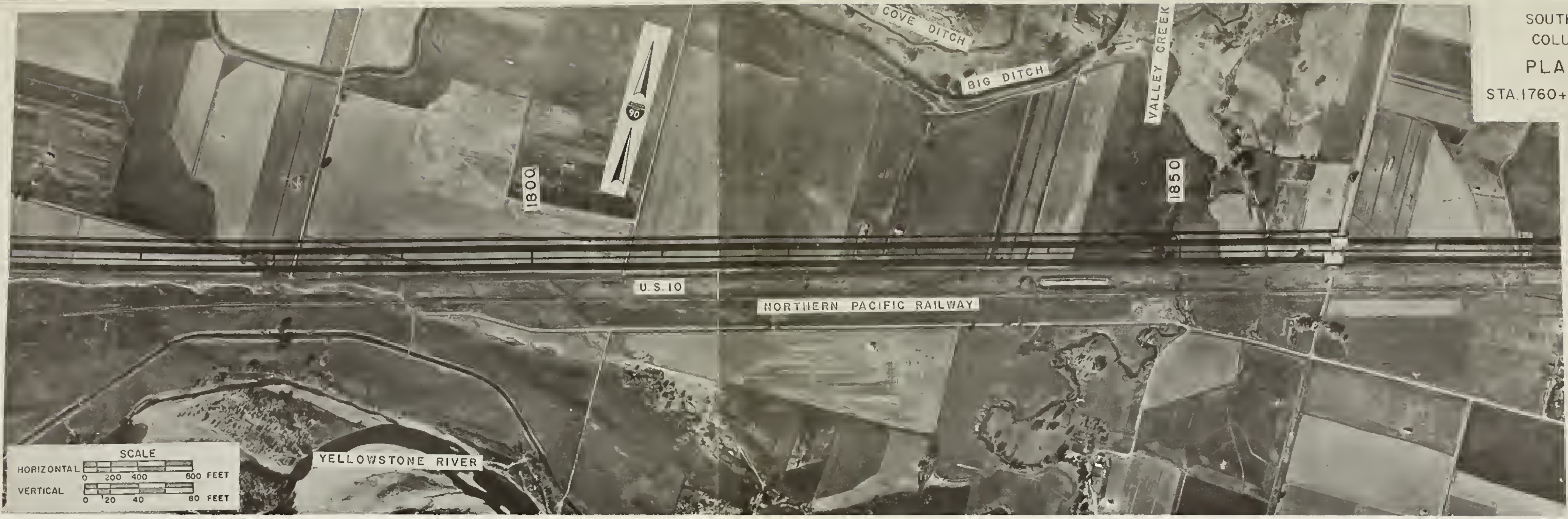


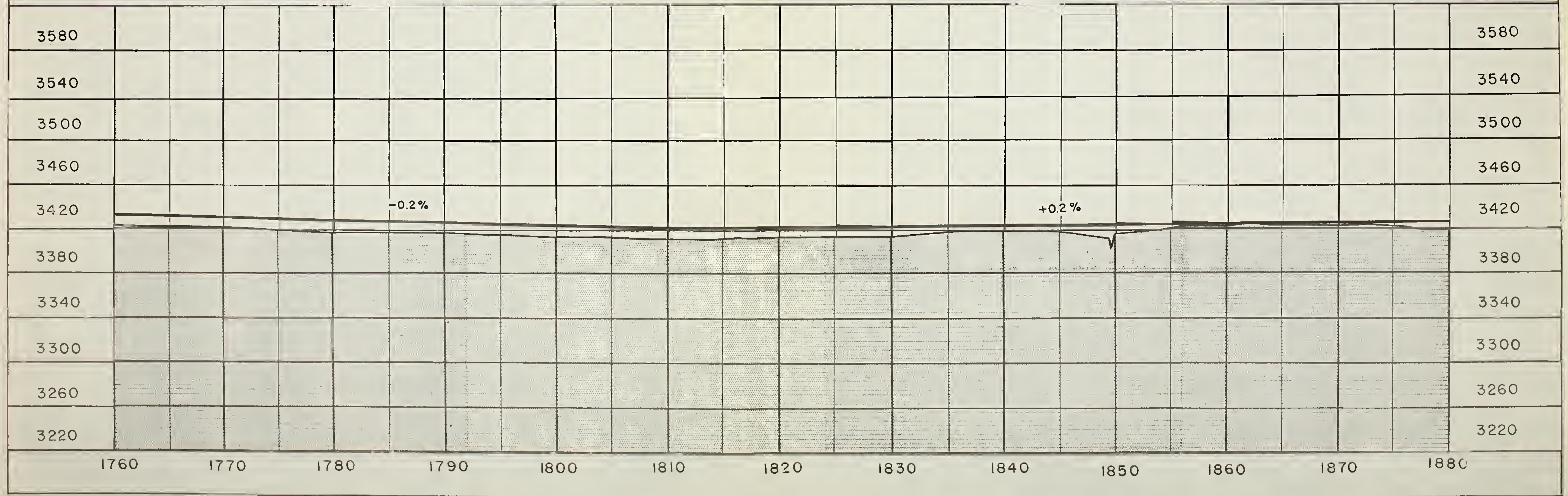


SOUTH ALTERNATE
COLUMBUS-EAST

PLAN & PROFILE

STA.1760+00 TO STA.1880+00





SOUTH ALTERNATE
COLUMBUS-EAST

PLAN & PROFILE

STA. 1870+00 TO STA. 1888+00